FORM PTO-1390 (Modified) (REV 10-95) U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

ATTORNEY'S DOCKET NUMBER	U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR)
0154-2903-2 PCT	09/530948

INTERNATIONAL APPLICATION NO	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/FR98/02458	18 NOVEMBER 1998	18 NOVEMBER 1997

TITLE OF INVENTION

PROCESS FOR RELAYING IP APPLICATION FRAMES WITHIN AN ATM NETWORK SWITCH WITH DISTRIBUTED ARCHITECTURE

APPLICANT(S) FOR DO/EO/US

Marc BAVANT, et al

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☒ This is an express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).
4. ☒ A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.
5. ☒ A copy of the International Application as filed (35 U.S.C. 371 (c) (2))
   a. ☐ is transmitted herewith (required only if not transmitted by the International Bureau).
   b. ☒ has been transmitted by the International Bureau.
   c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☒ A translation of the International Application into English (35 U.S.C. 371(c)(2)).
7. ☒ A copy of the International Search Report (PCT/ISA/210).
8. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371 (c)(3))
   a. ☐ are transmitted herewith (required only if not transmitted by the International Bureau).
   b. ☐ have been transmitted by the International Bureau.
   c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
   d. ☒ have not been made and will not be made.
9. ☐ A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
10. ☒ An oath or declaration of the inventor(s) (35 U.S.C. 371 (c)(4)).
11. ☒ A copy of the International Preliminary Examination Report (PCT/IPEA/409).
12. ☐ A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371 (c)(5)).

Items 13 to 18 below concern document(s) or information included:

13. ☒ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
14. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
15. ☒ A **FIRST** preliminary amendment.
    A **SECOND** or **SUBSEQUENT** preliminary amendment.
16. ☐ A substitute specification.
17. ☐ A change of power of attorney and/or address letter.
18. ☐ Certificate of Mailing by Express Mail
19. ☒ Other items or information:

Notice of Priority
PCT/IB/304
PCT/IB/308
Drawings (5 sheets)
List of Related Cases
Cited References (3)
Form PTO 1449
Request For Consideration of Documents Cited in International Search Report

U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR	INTERNATIONAL APPLICATION NO.	ATTORNEY'S DOCKET NUMBER
09/530948	PCT/FR98/02458	0154-2903-2 PCT

20. The following fees are submitted:.

BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)) :

		CALCULATIONS PTO USE ONLY
☒	Search Report has been prepared by the EPO or JPO	**$840.00**
☐	International preliminary examination fee paid to USPTO (37 CFR 1.482)	**$670.00**
☐	No international preliminary examination fee paid to USPTO (37 CFR 1.482) but international search fee paid to USPTO (37 CFR 1.445(a)(2))	**$760.00**
☐	Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2) paid to USPTO	**$970.00**
☐	International preliminary examination fee paid to USPTO (37 CFR 1 482) and all claims satisfied provisions of PCT Article 33(2)-(4)	**$96.00**

ENTER APPROPRIATE BASIC FEE AMOUNT =	**$840.00**	
Surcharge of **$130.00** for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492 (e)).	**$0.00**	

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE		
Total claims	4 - 20 =	0	x $18.00	**$0.00**	
Independent claims	1 - 3 =	0	x $78.00	**$0.00**	
Multiple Dependent Claims **(check if applicable)**.			☐	**$0.00**	
TOTAL OF ABOVE CALCULATIONS =				**$840.00**	
Reduction of 1/2 for filing by small entity, if applicable. Verified Small Entity Statement must also be filed (Note 37 CFR 1.9, 1.27, 1.28) **(check if applicable)**.			☐	**$0.00**	
SUBTOTAL =				**$840.00**	
Processing fee of **$130.00** for furnishing the English translation later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492 (f)). +				**$0.00**	
TOTAL NATIONAL FEE =				**$840.00**	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31) **(check if applicable).**			☐	**$0.00**	
TOTAL FEES ENCLOSED =				**$840.00**	
				Amount to be: refunded	$
				charged	$

☒ A check in the amount of **$840.00** to cover the above fees is enclosed.

☐ Please charge my Deposit Account No. in the amount of to cover the above fees.
A duplicate copy of this sheet is enclosed.

☒ The Commissioner is hereby authorized to charge any fees which may be required, or credit any overpayment to Deposit Account No. **15-0030** A duplicate copy of this sheet is enclosed.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

OBLON, SPIVAK, McCLELLAND, MAIER & NEUSTADT, P.C.
Crystal Square Five, Fourth Floor
1755 Jefferson Davis Highway
Arlington, Virginia 22202
US

Telephone Number (703) 413-3000
Facsimile Number (703) 413-2220

WILLIAM E. BEAUMONT
REGISTRATION NUMBER 30,996

SIGNATURE

Marvin J. Spivak
NAME

24,913
REGISTRATION NUMBER

May 15, 2000
DATE

0154-2903-2 PCT

IN THE UNITED STATES PATENT & TRADEMARK OFFICE

IN RE APPLICATION OF: :

MARC BAVANT ET AL. :

SERIAL NO: NEW U.S. PCT APPLN. : ATTN: APPLICATION BRANCH
(Based on PCT/FR98/02458)

FILED: HEREWITH :

FOR: PROCESS FOR RELAYING IP APPLICATION FRAMES WITHIN AN ATM NETWORK SWITCH WITH DISTRIBUTED ARCHITECTURE

PRELIMINARY AMENDMENT

ASSISTANT COMMISSIONER FOR PATENTS
WASHINGTON, D.C. 20231

SIR:

Prior to a first examination on the merits, please amend the above-identified application as follows:

IN THE SPECIFICATION

Page 1, before line 1, insert --TITLE OF THE INVENTION--;

between prenumbered lines 2 and 4, insert:

--BACKGROUND OF THE INVENTION

Field of the Invention:--;

between prenumbered lines 7 and 8, insert --Discussion of the Background:--.

Page 10, between lines 4 and 5, insert:

--SUMMARY OF THE INVENTION--;

between lines 31 and 32, insert:

--BRIEF DESCRIPTION OF THE DRAWINGS--.

Page 11, between lines 19 and 20, insert:

--DESCRIPTION OF THE PREFERRED EMBODIMENTS--.

IN THE CLAIMS

Please amend Claims 1-3 as follows:

Claim 1, line 4, delete "(7i. . .7k)";

line 5, delete "(7j)";

line 12, delete "(7i. . .7k)";

line 14, delete "(9i. . .9k)";

line 15, delete "(logical path, outbound direction)";

line 19, delete "(9i. . .9k)";

line 21, delete "(4)";

line 23, delete "(9i. . .9k)", same line, delete "(4)".

Claim 2, line 3, delete "(7i. . .7k)";

line 9, delete "(7i. . .7k)";

line 11, delete "(7j)";

line 12, delete "(7j)";

line 14, delete "(7j)";

line 17, delete "(7j)".

Claim 3, line 1, change "any one of Claims" to --Claim--;

line 2, delete "and 2";

line 3, delete "(7j)";

line 4, delete "(11_n)";

line 10, delete "(11_n)";

line 12, delete "(9i. . .9k)".

Please add new Claim 4 as follows:

--4. Process according to Claim 2, characterized in that it consists:

- in allocating in each egress junctor a queue for each user pair, the second of whom is attached to the relevant junctor, that is to say that the direct connection between himself and the corresponding router LEC module passes through this junctor,

- in dynamically allocating the internal indices and the egress queues in conjunction with the updating of the ingress translation caches,

- and in using a mode for arbitration in PDU mode between the various queues so as to ensure the transmission of the cells without interleaving of the PDU frames.--

IN THE ABSTRACT

Please delete the original abstract sheet in its entirety and insert therefor

--ABSTRACT OF THE DISCLOSURE

A process relating to the relaying of IP frames in the form of PDU application frames within an ATM switch with distributed architecture and egress storage including a management module and several ingress and egress junctors having a routing emulation function ensuring IP frame routing between the users of various ELAN media and represented in each of these ELANs by its router LEC module. The process offloads the frame relay function into the ATM layer of the junctors by examining the first cell of each PDU

application frame arriving at an ingress junctor so as to extract therefrom the IP address of the destination, by searching in a cache table of the junctor for a pair opposite the relevant IP address and opposite the ingress logical path and by using the translation obtained for all the cells of the PDU application frame. The cache table is updated by virtue of the routing information originating from the routing emulation function residing in the management module. A request to update the cache is transmitted to the management module if the sought-after IP address is not located thereat or if the information opposite this address is too old. Such a process may find particular application in ATM communications networks.--

REMARKS

Favorable consideration of this application, as presently amended, is respectfully requested.

The present preliminary amendment is submitted to place the above-identified application in more proper format under United States practice. By the present preliminary amendment the specification has been amended to include suggested headings. The claims have been amended to delete all reference numerals and multiple dependencies. The subject matter of the canceled multiple dependency is also now submitted in new dependent Claim 4. A new Abstract believed to be in more proper format under United States practice is also submitted herein.

The present application is believed to be in condition for a full and thorough examination on the merits. An early and favorable consideration of the present application is hereby respectfully requested.

Respectfully submitted,

OBLON, SPIVAK, McCLELLAND,
MAIER & NEUSTADT, P.C.

Gregory J. Maier
Registration No. 25,599
Attorney of Record
Surinder Sachar
Registration No. 34,423

Crystal Square Five - Fourth Floor
1755 Jefferson Davis Highway
Arlington, Virginia 22202
(703) 413-3000
Fax #: (703)413-2220
GJM:SNS/smi

I:\atty\SNS\0154\01542903.pr

PROCESS FOR RELAYING IP APPLICATION FRAMES WITHIN AN ATM NETWORK SWITCH WITH DISTRIBUTED ARCHITECTURE.

The present invention relates to a process for relaying IP application frames within an ATM network switch with distributed architecture and egress storage.

Communications networks known by the abbreviation ATM standing for "Asynchronous Transfer Mode" allow the dissemination of fixed-length packets dubbed "ATM cells", consisting of a five-byte header and a forty-eight-byte payload. The header contains in particular a logical path identifier, dubbed the VPI/VCI field, the abbreviation standing for "Virtual Path Identification and Virtual Channel Identifier" which allows the cell to be steered through the switches which it encounters on its journey between the sending user and the destination user.

The applications which are able to use ATM networks for communicating the data are very diverse. Most of the applications capable of using ATM networks have a format specific to their data: it may, for example, involve frames in the IP format of the "INTERNET" protocol or else frames in the format of the MPEG standard where MPEG is the abbreviation standing for "Moving Picture Expert Group". Adaptation between the format of the application frames and the format of the ATM cells is performed in a layer known as the adaptation layer, designated by the abbreviation AAL standing for "ATM Adaptation Layer", this layer being in particular responsible for segmenting the frames into cells and conversely for reassembling the cells received from the network into frames.

Any ATM switch employs, in the manner represented in Figure 1a, four major sets of functions, an access function 1 for accessing each port of an ATM switch, an ATM layer function 2, a cross-connection function 3 and a management function 4.

The access function 1 ensures the conversion of the ATM cells into the format suitable for the transmission carrier linked to the said port and vice versa. This function makes it possible to present the inbound cells to the ATM layer in a single format which is independent of the nominal throughput and of the optical, electrical, radio, etc. technology of the transmission carrier from which they originate. The ports of a switch make it possible to link several switches together but they also make it possible to link a user of the ATM services to a switch.

The processing operations to be implemented in the access function are described in an ample standards literature, both from the ANSI and from the ITU and the ATM Forum. The major classes of interface which are defined in these documents are:

The PDH interface, the abbreviation standing for "Plesiochronous Digital Hierarchy", defined in the document ITU-T G.804, G.703.

The SDH interface, the abbreviation standing for "Synchronous Digital Hierarchy", defined in the document ITU-T G.708, etc.

The SONET interface, the abbreviation standing for "Synchronous Optical Network", defined in the document ANSI-T 1.105, etc.

The 25.6 Mbit/s IBM interface defined in the document af-phy-0040.000.

The ATM layer function 2 groups together several functions such as in particular the management of the cell headers, the translation of the VPI/VCI logical paths, the abbreviation standing for "Virtual Path Identification and Virtual Channel Identifier", the processing of OAM management cells, the abbreviation standing for "Operations Administration and Maintenance", an important part of the traffic management which comprises the subfunctions known by the abbreviations UPC standing for "Usage Parameter Control", SCD standing for "Selective Cell Discard",

EPD standing for "Early PDU Discard", RM cells the abbreviation standing for "Resource Management", etc.

The processing operations to be implemented in the ATM layer function are described in particular in the following standards documents from the ITU and the ATM Forum:

- B-ISDN ATM Layer Specification [ITU-T I.361]

- B-ISDN Operation and Maintenance Principles and Functions [ITU-T I.610]

- Traffic Management Specification Version 4.0 [AF-TM 4.0]

The cross-connection function 3 switches the cells from an ingress direction to one or more egress directions, depending on indications formulated by the ATM layer when translating logical paths.

This function is at the heart of any ATM switch and it has formed the subject of an ample literature which need not be recalled here. The cross-connection ring and the cross-connection network constitute two frequent types of implementation of this function.

The management function 4 comprises subfunctions such as: local supervision of the switch (alarms, discovery of the configuration of the switch and of the local topology, management of versions, etc.), dialogue with the centralized supervision of the network, the dialogues required for establishing switched virtual circuits, etc.).

For a more detailed description of some of these subfunctions, reference may be made for example to the standards literature of the ATM Forum:

- ATM User-Network Interface (UNI) Signaling Specification Version 4.0 (af-sig-0061.000)

- Private Network-Network Interface Specification Version 1.0 (af-pnni-0055.000)

- Integrated Layer Management Interface (af-ilmi-0065.000)

These various functions interface with one another as indicated below. It should be noted that the management function behaves exactly like a user except

that its linkup with the ATM layer does not pass through an external port of the switch, and, therefore, does not require any access function. On the other hand, the management function deals only with ATM cells and also with messages which it must therefore segment and reassemble by way of an AAL adaptation layer which therefore constitutes an additional function: the adaptation function.

A conventional switch architecture consists in distributing the functions over distinct hardware facilities, possibly duplicated so as to allow backup of a defective facility of the same nature, and which are implanted in the switch in sufficient number to satisfy the processing load forecast as a function of the configuration of the network at this spot. In practice, these facilities are electronic-component cards joined together in a rack and conversing with one another via one or more data buses fitted to the backplane. They define what is commonly referred to as a "distributed architecture".

Traditionally, the hardware architecture of a distributed ATM switch distinguishes, as shown in Figure 1b, three types of modules: a cross-connector module 5, a management module 6 and junctor modules 7_1 ... 7_n. The functions of the switch are shared among these various modules with the constraint however that the junctor modules deal at least with the access function, the cross-connector module 5 with the cross-connection function and the management module 6 with the management function.

In Figure 1b, the links 8_1 ... 8_n existing between each junctor module and the cross-connector module are called "cross-connector junctions". Furthermore, each junctor implements an access function capable of managing one or more ports. When a cell passes through a switch, it begins by passing through a first junctor, the so-called "ingress junctor" for this cell, then a second junctor, the so-called "egress junctor". Since several ingress junctors can

simultaneously despatch cells to one and the same egress junctor, cell congestion may occur on account of the limited egress throughput of this egress junctor. Cell storage and queuing mechanisms are then triggered while waiting for the congestion to be cleared. These storage mechanisms may be located at the ingress, at the egress, in the cross-connector or in several of these elements at once. One then speaks of an architecture with "ingress storage", "egress storage", etc.

The users of a communications network can envisage several modes for exchanging their data. These modes are represented schematically in Figures 2a to 2f. The point-to-point mode, Figure 2a, puts in touch two users A, D exclusively, each of them being able to be a sender and receiver. In this mode, anything which one of the users sends is received by the other. A variant of the point-to-point mode consists in specializing the sender or receiver roles of each of the two users (unidirectional point-to-point communication).

The point-to-multipoint mode, Figure 2b, puts in touch more than two users A, C, D, one of whom is exclusively a sender and the others exclusively receivers. Anything which is sent by the sender is received by all the receivers.

The multipoint-to-point mode, Figure 2c, also puts in touch more than two users A, B, C, one of whom is exclusively a receiver and the others exclusively senders. Anything which is sent by one of the senders is received by the receiver.

Finally, the multipoint-to-multipoint mode, not represented, puts in touch at least two [sic] users A, B, C, D, each able to be a sender and receiver. In this last mode, anything which is sent by any one of the users is received by all the other users and also by the sender.

The multipoint-to-multipoint and point-to-multipoint communications are especially natural in the

case of a shared-medium communication network such as Ethernet networks as represented schematically in Figure 2e. Indeed, in this case, all the users are linked to a single medium and all the stations A, B, C, D connected to this medium receive all messages despatched by the other stations. On the contrary, in the case of an ATM network, as represented schematically in Figure 2f, the broadcasting to multiple destinations A, B, C, D of a cell sent by one of the users requires that the network should itself generate the copies of the cell in question.

The term "connection" refers to any communication according to one of the modes defined hereinabove, between a well-defined set of users, this communication being endowed with a specific list of attributes such as: service quality parameters, traffic parameters, etc.

The implementation within an ATM network of communications in the various modes defined hereinabove may be considered from several points of view, in particular: signalling, routing, conveying of the data and management of the resources.

As far as point-to-point connections are concerned, the signalling and routing aspects are amply described in the documents ([ITU-T Q.2931], [AF-SIG 4.0], [AF-PNNI1.0], [AF-IISP]) of the standards literature.

They consist in determining a route through the network between the two users, such that this route satisfies the traffic and service quality constraints of the connection. The route is characterized by a list of highways. Each switch of the route allocates the connection a logical path number relating to the ingress highway of the connection into the switch and maintains a translation table which matches up this identifier with the outbound direction to be taken by the cell and the logical path identifier of the connection in the next switch. Thus, any cell of a connection can be steered gradually simply by

consulting the logical path identifier present in the cell header and the local translation table.

In a switch with distributed architecture, such as the one of Figure 1b, this translation can be performed by the ATM layer function of the ingress junctor. The cell is then sent back to the cross-connector module together with an indication of the egress cross-connection junction to which the cross-connector must switch the cell. This indication can be despatched in a specific header prefixed to the start of the cell. Translation devices in accordance with this particular case have been described by the applicant, for example in French patent applications No. 2 670 972, 2 681 164, 2 726 669 and French application FR 97 07355 not yet published.

Symbolically, the point-to-multipoint connections can be represented by a "tree" with a "root" representing the sender user and its "leaves" representing the receiver users. The implementation of this type of connection is standardized as regards the signalling and routing. It involves simply forming a point-to-multipoint connection by first creating a point-to-point connection and then by grafting new leaves onto it. This adding of leaves can be done on the initiative of the root or else of the leaf.

As regards the conveying of the cells, the model of the point-to-point connection, that is to say the ingress translation only, cannot always be applied. In Figure 3a where the elements counterpart to those of Figure 1b are labelled with the same references, a point-to-multipoint connection is represented. This connection enters the switch via a port P1 and leaves it via the ports P2, P4, P5, P7. In this case, the ingress translation envisaged above can order the cross-connector 5 to copy each cell of this connection to the three cross-connector junctions concerned (7_3, 7_4, 7_n) but it is not capable of indicating the egress ports to which the cell should be despatched. To do this, it is necessary to append this information to the

translation tables and to convey it from the ingress to the egress. Moreover, the egress logical path depends on each egress port and it cannot be allocated a unique logical path for all the egresses.

For all these reasons, it is generally preferred to carry out a double translation: an ingress translation which replaces the logical path of the cell by a "broadcast index" representative of the connection within the switch, then a second translation at egress which translates the broadcast index into a list of pairs of the form (port, logical path) together with any necessary copies.

The multipoint-to-point and multipoint-to-multipoint connections are not at present dealt with in the standardizing facilities concerned with ATM. Hence, there is for the moment no signalling nor routing defined for this type of connection.

In terms of cell conveying, any communication topology which brings data from different geographical origins to converge to one and the same link poses the problem of so-called "interleaving of the PDU application frames", PDU being the abbreviation standing for "Protocol Data Unit". Indeed, the application frames (PDUs) being segmented by the AAL layer into cells, the cells of various frames arrive interleaved at the destination. To reassemble the frames, the destination would have to be able to rediscover which frame each cell belongs to. Now, the segmentation mechanism used most commonly in UBR connections, implemented within the AAL adaptation layer 5, does not allow this identification. It allows only the identification of the last cell of the PDU frame, this being sufficient in point-to-point or point-to-multipoint modes since the ATM cells are transmitted in sequence.

Despite all these problems, communications needs in multipoint-to-point and multipoint-to-multipoint mode exist. They could be dealt with theoretically by superposing point-to-point or point-

to-multipoint connections. The case is apparent in particular within the framework of local area network emulation known by the abbreviations LAN Emulation or LANE, standing for "Local Array Network Emulation", where any sophisticated mechanism is set in place for emulating a shared medium (ELAN) within an ATM network [AF LANE]. Each user is assigned an LEC function (Lan Emulation Client). The shared-medium emulator makes it possible to achieve multipoint-to-multipoint communications by using the server known by the abbreviation BUS, standing for "Broadcast or Unknown Server" which is defined in the LANE standard, and whose architecture is shown in Figure 3b, which a user can employ to transmit messages broadcast to all the users of an emulated shared medium, or to another user to whom he is not yet directly linked. Each user of the ELAN possesses a point-to-point connection to the BUS server and the BUS server possesses a point-to-multipoint connection to all the users of the ELAN, as indicated in Figure 3b.

Another example of a need in multipoint-to-point and multipoint-to-multipoint communications is provided by the emulation of routing between local area networks. This function can in particular be implemented according to the standard known by the abbreviation MPOA, standing for "Multiprotocol Over ATM" of the ATM Forum which makes it possible to perform a virtual routing between various emulated local area networks (ELANs) or various virtual local area networks (VLANs) or an ELAN [AF MPOA]. Another way of performing the routing emulation consists in embedding routing software within the management unit of the ATM switch. Such an embedded routing emulation function is designated hereinafter as virtual router. In this context, the virtual router is akin to a user of the various ELANs which it interconnects. In this regard, an LEC function (router LEC) must correspond thereto for each ELAN. The virtual router must be implemented in a switch, for example by a specific

procedure executed within the management module, thereby incurring the risk of clogging up the said module when the exchanges between the ELANs are sufficiently supported.

The aim of the invention is to alleviate the aforesaid drawbacks.

To this end, the subject of the invention is a process for relaying IP frames in the form of PDU application frames within an ATM switch with distributed architecture and egress storage comprising a management module and several ingress and egress junctors having a routing emulation function ensuring IP frame routing between the users of various ELAN media and represented in each of these ELANs by its router LEC module, characterized in that it consists in offloading the frame relay function into the ATM layer of the junctors by examining the first cell of each PDU application frame arriving at an ingress junctor so as to extract therefrom the IP address of the destination, by searching in a cache table of the junctor for a pair (logical path, outbound direction) opposite the relevant IP address and opposite the ingress logical path and by using the translation obtained for all the cells of the PDU application frame, the cache table being updated by virtue of the routing information originating from the routing emulation function residing in the management module and in that it consists in transmitting a request to update the cache to the management module if the sought-after IP address is not located thereat or if the information opposite this address is too old.

Other characteristics and advantages of the invention will become apparent with the aid of the description which follows with reference to the appended drawings which represent:

- Figure 1a, a basic diagram of an ATM switch according to the prior art,

- Figure 1b, a basic diagram of an ATM switch with distributed architecture according to the prior art,

- Figures 2a to 2f, diagrams illustrating communication modes between users of an ATM network,

- Figure 3a, an example of steering an ATM cell through a switch during a point-to-multipoint connection,

- Figure 3b, an example of superimposing point-to-point or point-to-multipoint connections in an emulated LAN architecture,

- Figure 3c, a basic diagram of a routing between ELANs,

- Figure 3d and 3e, an illustration of the dynamic short-circuiting procedure implemented by the invention,

- Figure 4, an example of organizing an ATM switch for implementing the process according to the invention.

The process according to the invention makes it possible to alleviate the prior art drawback cited above as regards the excessive load of the management unit within which a virtual router of IP frames is embedded. The process makes it possible, inside an ATM switch, to achieve a genuine decentralization of the IP relay function (or IP forwarding) by limiting the role of the router to its function for calculating routes, which is already known from the prior art.

Figure 3c shows a case where this process is usable. The virtual router possesses as many router LEC modules as ELANs which it knows. If the user UA belonging to the ELAN A wishes to despatch an IP frame destined for a user UB, he begins by using the means for broadcasting on the ELAN A (BUS broadcast server). If the internal router in the switch knows of the existence of user UB, the LEC A module of this router, associated with the ELAN A, declares itself to the destination of all the IP frames destined for the user UB. Subsequently the user UA establishes and uses his

direct ATM connection with the LEC A, according to the usual process specified in the LANE standard, so as to send frames destined for the user UB. According to the prior art, the frames have to backtrack to the internal router of the management module, so as to relay them to the user UB using the direct ATM connection which exists between the LEC B module and the user UB.

The process according to the invention specifies that for any application frame PDU arriving at a direct connection involving the LEC A module, the ingress junctor examines its first cell and extracts the IP address of the destination therefrom. It then runs through a cache table updated by virtue of the routing information originating from the management module, and finds therein opposite the IP address and opposite the inbound logical path a pair (logical path, outbound direction). The outbound direction is the identifier of the cross-connector junction involved in the direct connection between the LEC B module of the user UB. The logical path is an internal index making it possible to retrieve the logical path of this connection by virtue of an egress translation mechanism which will be described hereinbelow. If the ingress junctor does not find the IP address searched for in the cache table, it despatches a cache update request to the management module. The information found in the table then serves in translating the ATM header of each cell of the relevant PDU frame. This makes it possible, through a dynamic translation procedure, the translation table being modified potentially during the passage of each PDU frame, to thus establish a "dynamic short-circuit" between two point-to-point connections as shown diagrammatically in Figure 3d.

If the logical path found in the ingress translation table were simply the logical path associated with the direct connection between the LEC B module and the user UB, this would result in an interleaving between the various PDUs despatched

simultaneously by various users of the ELANs concerned to the same user UB of ELAN B.

In order to avoid this drawback the process according to the invention makes provision for a double translation. To do this, the ingress and egress junctors of the switch are furnished in the manner represented in Figure 4, where the elements counterpart to Figure 3c are represented with the same references, with translation tables 9. In Figure 4, where only two ingress junctors 7i and 7k and only one egress junctor 7j are represented, the translation tables of the ingress junctors 7i and 7k bear the references 9i and 9k respectively and the translation table of the egress junctor 7j bears the reference 9j. These translation tables make it possible in the example represented to connect sending users UA_1, UA_2 to destination users UB and UC, one of whom UB features a local area network. Each cell originating from a sending user addresses a translation table 9 via a pair of values formed of a logical path number and of the IP address ($@IP_1$, $@IP_2$, etc.) of the destination user. The logical path and IP address pair is transformed by the translation table 9 into a pair of values composed of an index value VM and of an identifier number L_j for an egress junctor j involved in the direct connection between the LEC B module of the management unit 4 and the LEC UB of the destination user. In the example of Figure 4, the translation table 9i of the junctor 7i carries out the translation of the pair (VLi (UA_1), $@IP_1$) into a pair (VM (UA_1, UB), L_j) where VLi (UA_1) is the logical path associated in the junctor 7i with the direct connection between the user UA_1 and the LEC A module of the management module 4, $@IP_1$ is the IP address of the destination user belonging to the local area network UB, VM (UX, UY) is a connection internal index number allocated to each pair of users (UX, UY) and L_j is the identifier of the cross-connector junction 7j involved in the direct connection between the LEC B module and the destination user UB.

Likewise according to this same principle, the example of Figure 4 shows an example of a connection between a user UA_2 and two destination users having respective addresses $@IP_2$ and $@IP_3$. In this example, communications from UA_2 to UB and from UA_2 to UC are each carried out in the junctor 7k via the following respective translations:

VL_k (UA_2, $@IP_2$) → (VM (UA_2, UB), L_j

and VL_k (UA_2, $@IP_3$) → (VM (UA_2, UC), L_j,

According to the invention, each egress junctor 7j has available a large number of queues 11_n such that one of these queues, Fj (UX, UY), can be allocated one-to-one to each pair (UX, UY) where UY is a user whose direct connection between himself and his LEC router LEC Y passes through the junctor 7j. An egress translation table 9j arranged in each of the egress junctors 7j carries out an egress translation of the value of the index VM (UX, UY) into a pair (VLj (UY), Fj (UX, UY), where VLj (UY) is the logical path associated in the egress junctor 7j with the direct connection between the user UY and the LEC Y module and Fj (UX, UY) is the number of the queue of the junctor 7j allocated to the pair (UX, UY).

The internal index VM (UX, UY) must allow the egress translation on the junctor 7j relevant to the user UY. It is not therefore necessary for the function VM associating an index with each pair (UX, UY) to be one-to-one (injective) since the translation of the index is carried out within the context of junctor j. The number of indices required in the entire switch is therefore the maximum of the number of egress queues in each of the junctors. Moreover, neither is it necessary for the function VM to be defined for every pair (UX, UY) since two unspecified users UX and UY do not always need to converse, or they may sometimes converse without going via the router if they belong to the same ELAN. The allocating of the indices and of the egress queues can therefore be done dynamically, as a function

of the needs expressed, for example in conjunction with the updating of the ingress translation caches.

Finally, an egress arbitrator which is within the scope of the person skilled in the art, and therefore not represented, carries out the extraction "in PDU mode" of the cells from the queues and their transmission over the physical interface. The "PDU mode" operation signifies that a queue is regarded as being ready to send only when it contains at least one complete PDU frame and when the arbitrator extracts only complete PDU frames.

CLAIMS

1. Process for relaying IP frames in the form of PDU application frames within an ATM switch with distributed architecture and egress storage comprising a management module and several ingress (7i...7k) and egress (7j) junctors having a routing emulation function ensuring IP frame routing between the users of various ELAN media and represented in each of these ELANs by its router LEC module, characterized in that it consists in offloading the frame relay function into the ATM layer of the junctors by examining the first cell of each PDU application frame arriving at an ingress junctor (7i...7k) so as to extract therefrom the IP address of the destination, by searching in a cache table (9i...9k) of the junctor for a pair (logical path, outbound direction) opposite the relevant IP address and opposite the ingress logical path and by using the translation obtained for all the cells of the PDU application frame, the cache table (9i...9k) being updated by virtue of the routing information originating from the routing emulation function residing in the management module (4) and in that it consists in transmitting a request to update the cache (9i...9k) to the management module (4) if the sought-after IP address is not located thereat or if the information opposite this address is too old.

2. Process according to Claim 1, characterized in that it consists in performing a double translation, a first translation in each ingress junctor (7i...7k) so as to transform the logical path number VLi (UX) between the user UX and the LEC module of the router relating to the ELAN to which the user UX belongs and the IP address of the destination of each application frame originating from the user (UX) applied to the ingress of a junctor (7i...7k) into an internal index number VM (UX, UY) and an identifier number L_j of an egress junctor (7j), a second translation in each egress junctor (7j) so as to transform the index number

VM (UX, UY) into a logical path number VLi (UY) associated in the egress junctor (7j) with the direct connection between the user UY and his corresponding router LEC A modulend a queue number for the egress junctor (7j) allocated to the pair (UX, UY).

3. Process according to any one of Claims 1 and 2, characterized in that it consists:

- in allocating in each egress junctor (7j) a queue (11_n) for each user pair, the second of whom is attached to the relevant junctor, that is to say that the direct connection between himself and the corresponding router LEC module passes through this junctor,

- in dynamically allocating the internal indices and the egress queues (11_n) in conjunction with the updating of the ingress translation caches (9i...9k),

- and in using a mode for arbitration in PDU mode between the various queues so as to ensure the transmission of the cells without interleaving of the PDU frames.

BIBLIOGRAPHIC APPENDIX

Article:

[HYOJEONG] A simple and fast sheduler [sic] for input queued ATM switches, Hyojeong Song et al., HPC ASIA '97

ATM Forum Standards:

[AF TM4.0] Traffic Management Specification Version 4.0, ATM Forum, af-tm-0056.000

[AF SIG4.0] ATM User-Network Interface (UNI) Signaling Specification Version 4.0, ATM Forum, af-sig-0061.000

[AF PNNI1.0] Private Network Interface Specification Version 1.0, ATM Forum, af-pnni-0055.000

[AF IISP] Interim Interswitch Signaling Protocol, ATM Forum af-pnni-0026.000

[AF LANE] LAN Emulation Over ATM Version 1.0, ATM Forum, af-lane-0021.000

[AF MPOA] Multiprotocol Over ATM Version 1.0, ATM Forum, af-mpoa-0087.000

ABSTRACT

Process for relaying IP application frames within an ATM network switch with distributed architecture

The process relates to the relaying of IP frames in the form of PDU application frames within an ATM switch with distributed architecture and egress storage comprising a management module and several ingress (7i...7k) and egress (7j) junctors having a routing emulation function ensuring IP frame routing between the users of various ELAN media and represented in each of these ELANs by its router LEC module, characterized in that it consists in offloading the frame relay function into the ATM layer of the junctors by examining the first cell of each PDU application frame arriving at an ingress junctor (7i...7k) so as to extract therefrom the IP address of the destination, by searching in a cache table (9i...9k) of the junctor for a pair (logical path, outbound direction) opposite the relevant IP address and opposite the ingress logical path and by using the translation obtained for all the cells of the PDU application frame, the cache table (9i...9k) being updated by virtue of the routing information originating from the routing emulation function residing in the management module (4).

A request to update the cache (9i...9k) is transmitted to the management module (4) if the sought-after IP address is not located thereat or if the information opposite this address is too old.

Applications: ATM communications networks.

Figure 4.

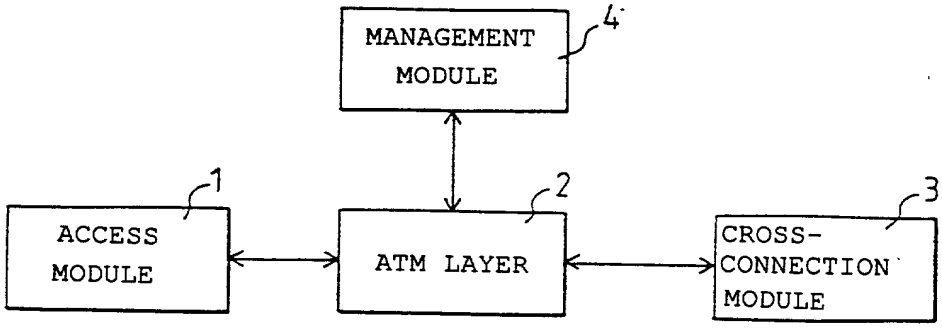

FIG.1a

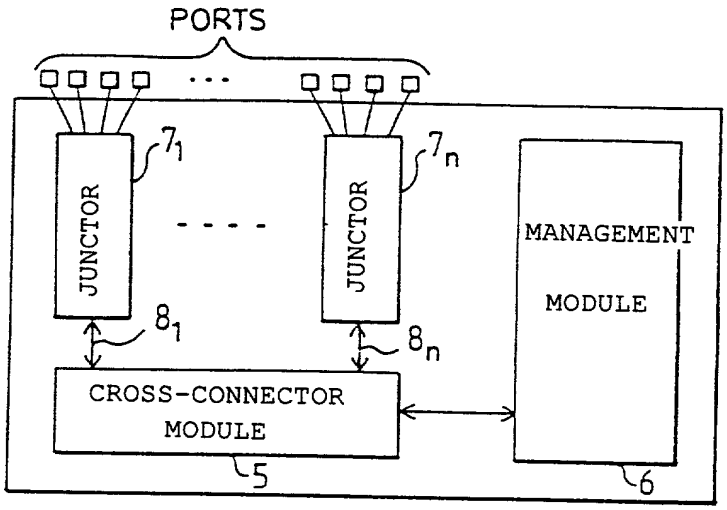

FIG.1b

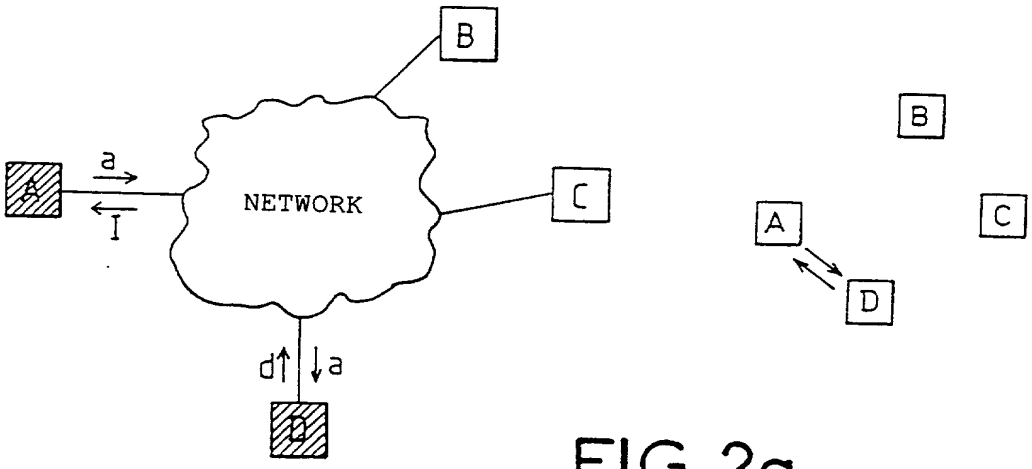

FIG.2a

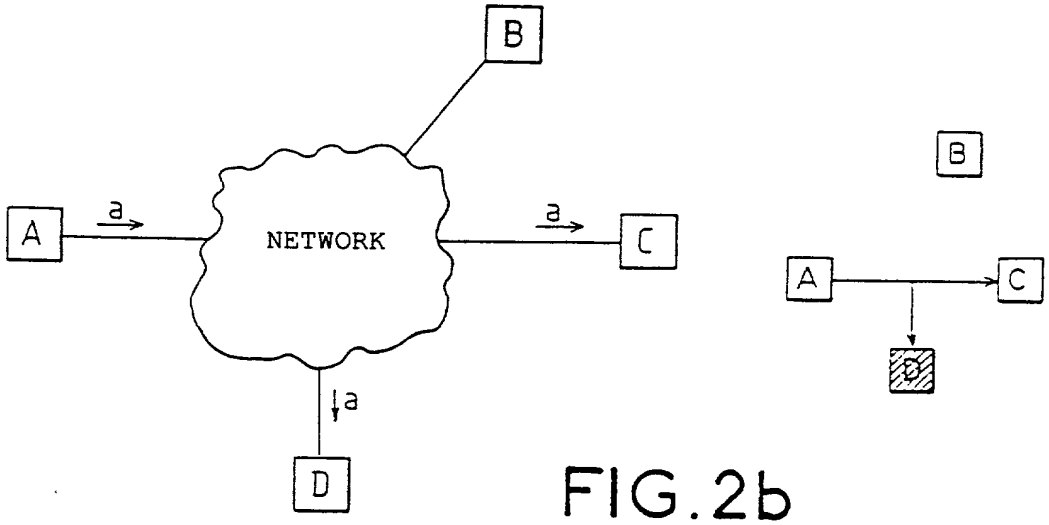

FIG. 2b

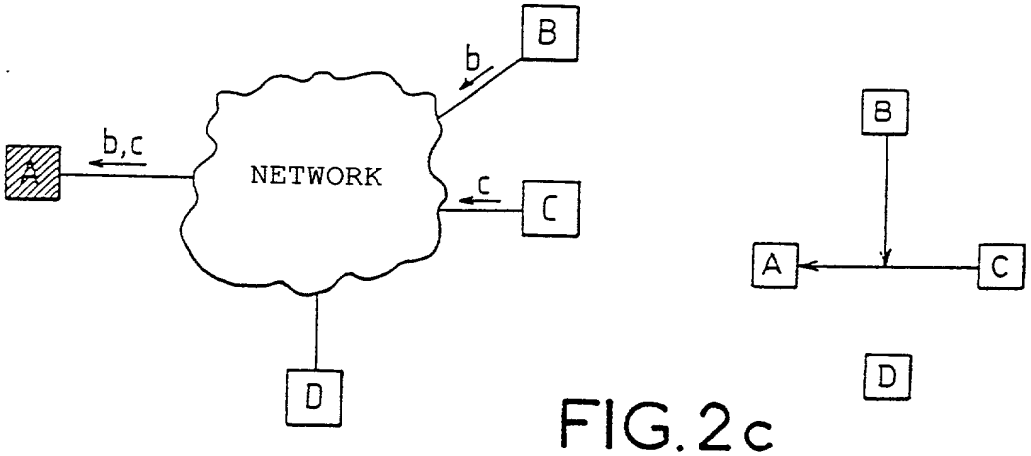

FIG. 2c

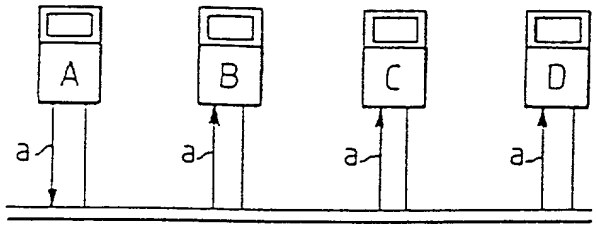

FIG. 2e

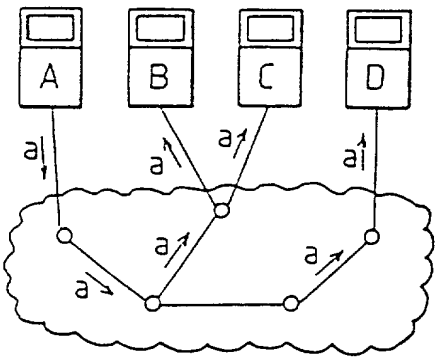

FIG. 2f

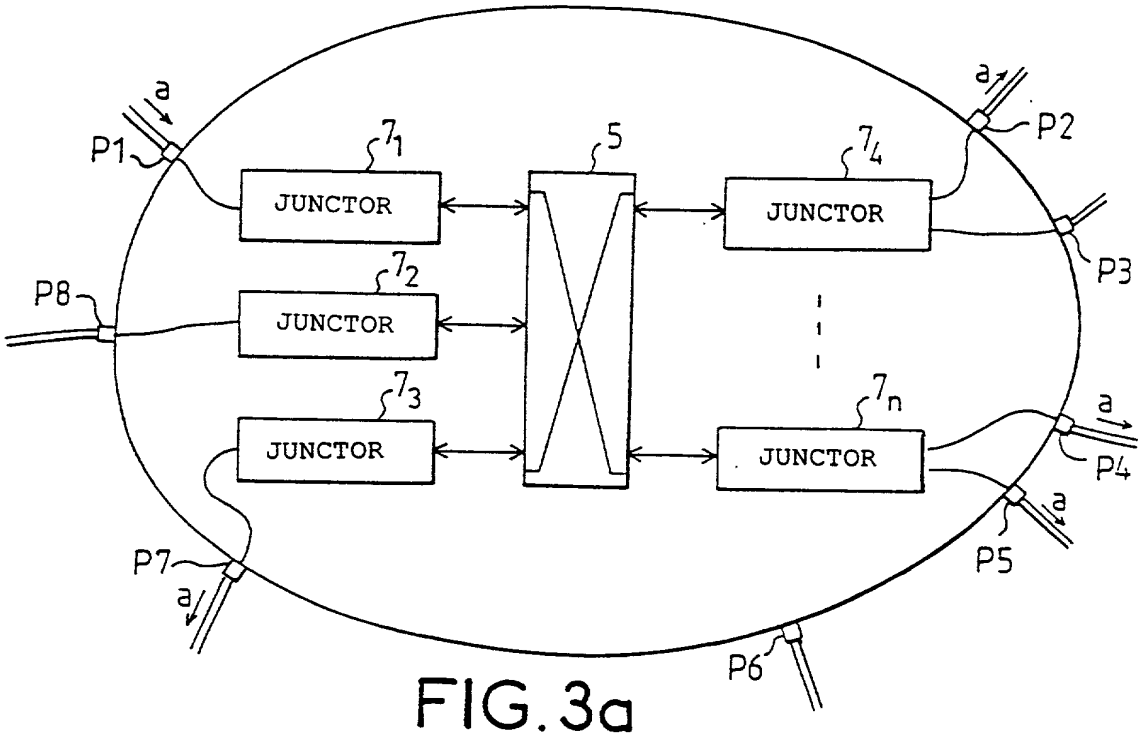

FIG.3a

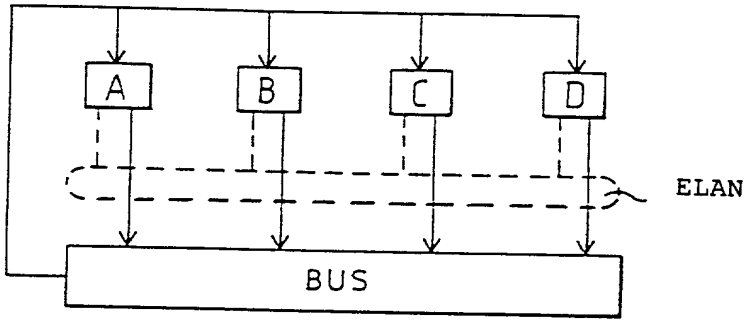

FIG.3b

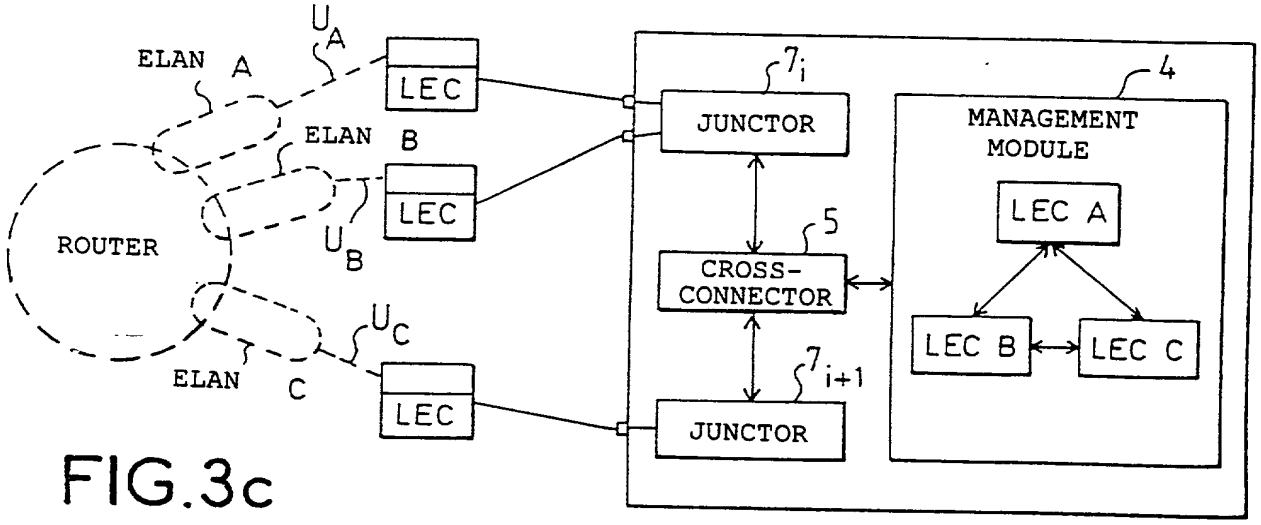

FIG.3c

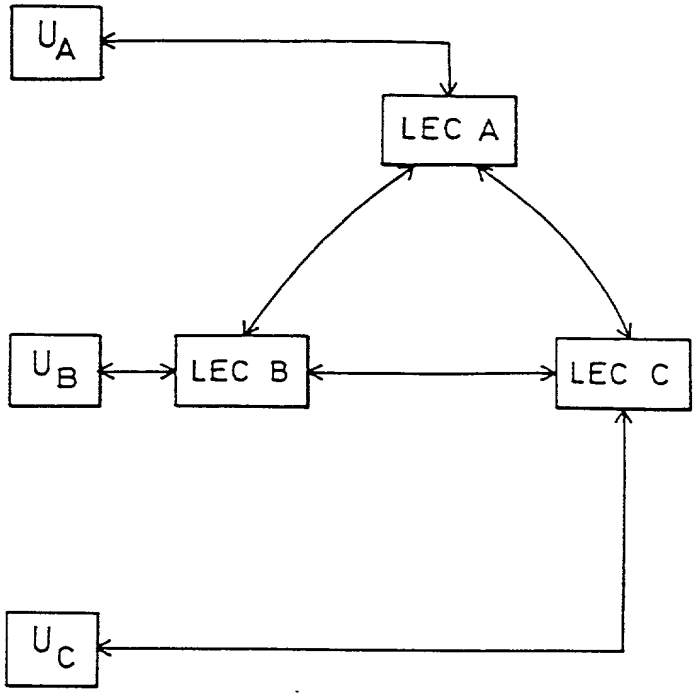

FIG.3d

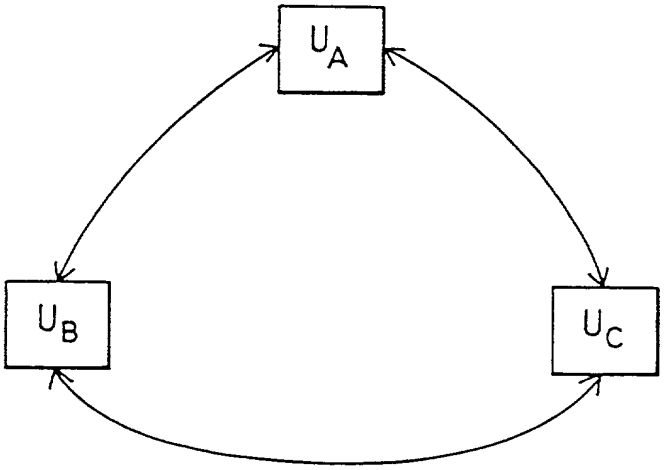

FIG.3e

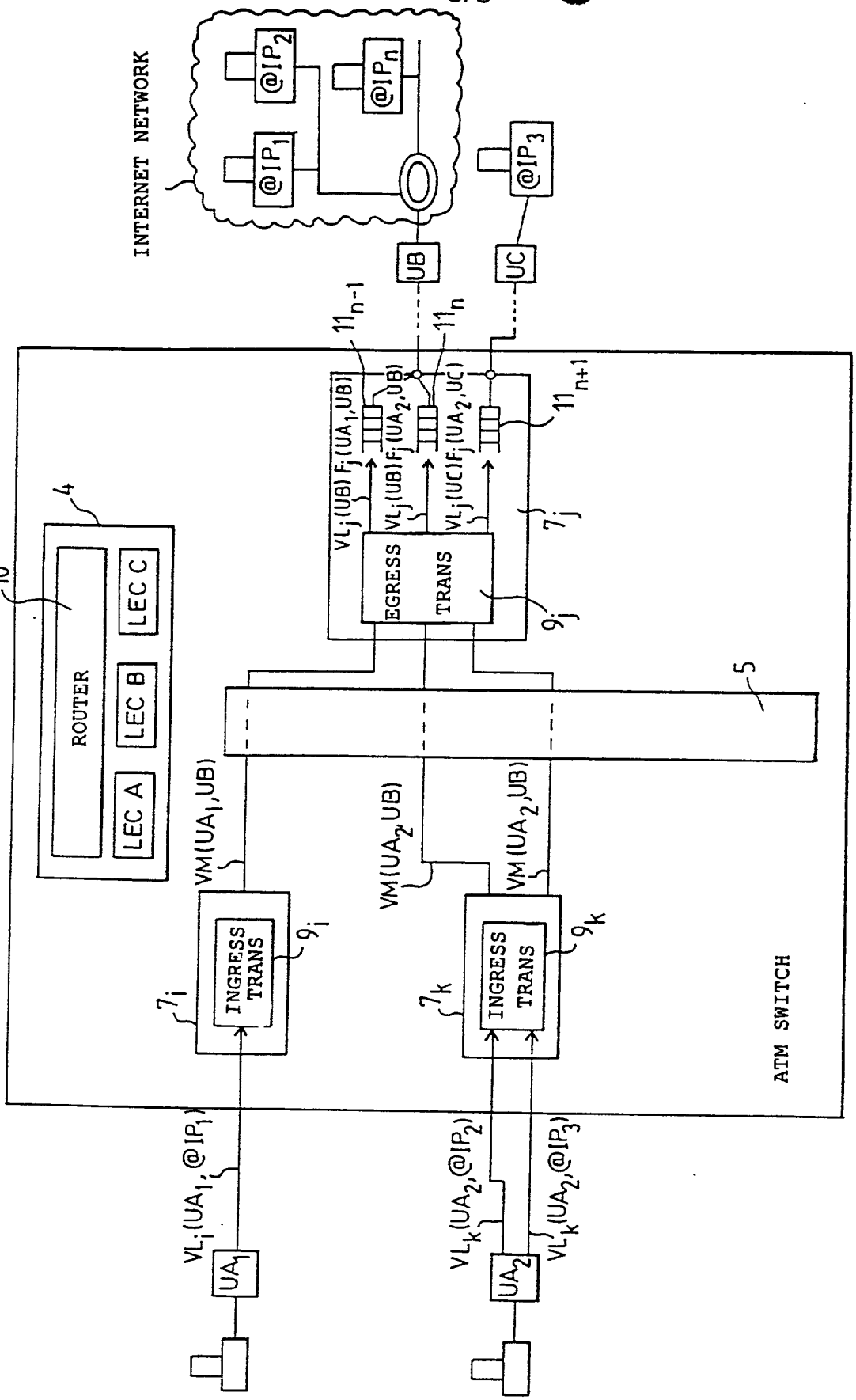
INTERNET NETWORK
@IP1
@IP2
@IPn
@IP3
UB
UC
11n-1
11n
11n+1
VLj(UB) Fj(UA1,UB)
VLj(UB) Fj(UA2,UB)
VLj(UC) Fj(UA2,UC)
EGRESS TRANS
7j
9j
4
10
ROUTER
LEC A
LEC B
LEC C
5
VM(UA1,UB)
VM(UA2,UB)
VM(UA2,UB)
INGRESS TRANS
7i
9i
7k
9k
ATM SWITCH
VLi(UA1,@IP1)
VLk(UA2,@IP2)
VL'k(UA2,@IP3)
UA1
UA2

FIG. 4

Declaration and Power of Attorney for Patent Application
Déclaration et Pouvoirs pour Demande de Brevet

French Language Declaration

En tant l'inventeur nommé ci-après, je déclare par le présent acte que:

As a below named inventor, I hereby declare that:

Mon domicile, mon adresse postale et ma nationalité sont ceux figurant ci-dessous à côté de mon nom.

My residence, post office address and citizenship are as stated next to my name.

Je crois être le premier inventeur original et unique (si un seul nom est mentionné ci-dessous), ou l'un des premiers co-inventeurs originaux (si plusieurs noms sont mentionnés ci-dessous) de l'objet revendiqué, pour lequel une demande de brevet a été déposée concernant l'invention intitulée

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

PROCESS FOR RELAYING IP APPLICATION FRAMES WITHIN AN ATM NETWORK SWITCH WITH DISTRIBUTED ARCHITECTURE

et dont la description est fournie ci-joint à moins

the specification of which.

☐ ci-joint

☐ a été déposée le _____

sous le numéro de demande des Etats-Unis ou le numéro de demande international PCT

_____ et modifiée le

_____ (le cas échéant).

☐ is attached hereto.

☒ was filed on 18 November 1998

as United States Application Number or PCT International Application Number

PCT/FR98/02458 and was amended on

_____ (if applicable).

Je déclare par le présent acte avoir passé en revue et compris le contenu de la description ci-dessus, revendications comprises, telles que modifiées par toute modification dont il aura été fait référence ci-dessus.

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

Je reconnais devoir divulguer toute information pertinente à la brevetabilité, comme défini dans le Titre 37, § 1.56 du Code fédéral des réglementations.

I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, § 1.56.

French Language Declaration

Je revendique par le présent acte avoir la priorité étrangère, en vertu du Titre 35, § 119(a)-(d) ou § 365(b) du Code des Etats-Unis, sur toute demande étrangère de brevet ou certificat d'inventeur ou, en vertu du Titre 35, § 365(a) du même Code, sur toute demande internationale PCT désignant au moins un pays autre que les Etats-Unis et figurant ci-dessous et, en cochant la case, j'ai aussi indiqué ci-dessous toute demande étrangère de brevet, tout certificat d'inventeur ou toute demande internationale PCT ayant une date de dépôt précédant celle de la demande à propos de laquelle une priorité est revendiquée

I hereby claim foreign priority under Title 35, United States Code, § 119(a)-(d) or § 365(b) of any foreign application(s) for patent or inventor's certificate, or § 365(a) of any PCT International application which designated at least one country other than the United States, listed below, and have also identified below, by checking the box, any foreign application for patent or inventor's certificate, or PCT International application having a filing date before that of the application on which priority is claimed.

Prior Foreign Application(s) Demande(s) de brevet anterieure(s) dans un autre pays			Priority claimed Droit de priorité revendiqué	
97 14446 (Number) (Numéro)	FRANCE (Country) (Pays)	18 NOVEMBER 1997 (Day/Month/Year Filed) (Jour/Mois/Anné de dépôt)	☒ Yes Oui	☐ No Non
(Number) (Numéro)	(Country) (Pays)	(Day/Month/Year Filed) (Jour/Mois/Anné de dépôt)	☐ Yes Oui	☐ No Non

Je revendique par le présent acte tout bénéfice, en vertu du Titre 35, § 119(e) du Code des Etats-Unis, de toute demande de brevet provisoire effectuée aux Etats-Unis et figurant ci-dessous.

I hereby claim the benefit under Title 35, United States Code, § 119(e) of any United States provisional application(s) listed below

(Application No.) (Nº de demande)	(Filing Date) (Date de dépôt)	(Application No.) (Nº de demande)	(Filing Date) (Date de dépôt)

Je revendique par le présent acte tout bénéfice, en vertu du Titre 35, § 120 du Code des Etats-Unis, de toute demande de brevet effectuée aux Etats-Unis, ou en vertu du Titre 35, § 365(c) du même Code, de toute demande internationale PCT désignant les Etats-Unis et figurant ci-dessous et, dans la mesure où l'objet de chacune des revendications de cette demande de brevet n'est pas divulgué dans la demande antérieure américaine ou internationale PCT, en vertu des dispositions du premier paragraphe du Titre 35, § 112 du Code des Etats-Unis, je reconnais devoir divulguer toute information pertinente à la brevetabilité, comme défini dans le Titre 37, § 1 56 du Code fédéral des réglementations, dont j'ai pu disposer entre la date de dépôt de la demande antérieure et la date de dépôt de la demande nationale ou internationale PCT de la présente demande

I hereby claim the benefit under Title 35, United States Code, § 120 of any United States application(s), or § 365(c) of any PCT International application designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of Title 35, United States Code, § 112, I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, § 1.56 which became available between the filing date of the prior application and the national or PCT International filing date of this application

PCT/FR98/02458 (Application No.) (Nº de demande)	18 Nòvember 1998 (Filing Date) (Date de dépôt)	(Status) (patented, pending, abandoned) (Statut) (breveté, en cours d'examen, abandonné)
(Application No.) (Nº de demande)	(Filing Date) (Date de dépôt)	(Status) (patented, pending, abandoned) (Statut) (breveté, en cours d'examen, abandonné)

Je déclare par le présent acte que toute déclaration ci-incluse est, à ma connaissance, véridique et que toute déclaration formulée à partir de renseignements ou de suppositions est tenue pour véridique; et de plus, que toutes ces déclarations ont été formulées en sachant que toute fausse déclaration volontaire ou son équivalent est passible d'une amende ou d' une incarcération, ou des deux, en vertu de la Section 1001 du Titre 18 du Code des Etats-Unis, et que de telles déclarations volontairement fausses risquent de compromettre la validité de la demande de brevet ou du brevet délivré à partir de celle-ci.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true, and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

French Language Declaration

POUVOIRS: En tant que l'inventeur cité, je désigne par la présente l'(les) avocat(s) et/ou agent(s) suivant(s) pour qu'ils poursuive(nt) la procédure de cette demande de brevet et traite(nt) toute affaire s'y rapportant avec l'Office des brevets et des marquees: *(mentionner le nom et le numéro d'enregistrement).*

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith: *(list name and registration number)*

Norman F. Oblon, Reg. No. 24,618; Marvin J. Spivak, Reg. No. 24,913; C. Irvin McClelland, Reg. No. 21,124; Gregory J. Maier, Reg. No.25,599; Arthur I. Neustadt, Reg. No. 24,854; Richard D. Kelly, Reg. No. 27,757; James D. Hamilton, Reg. No. 28,421; Eckhard H. Kuesters, Reg. No. 28,870; Robert T. Pous, Reg. No. 29,099; Charles L. Gholz, Reg. No. 26,395; Vincent J. Sunderdick, Reg. No. 29,004; William E. Beaumont, Reg. No. 30,996; Steven B. Kelber, Reg. No. 30,073; Robert F. Gnuse, Reg. No. 27,295; Jean-Paul Lavalleye, Reg. No. 31,451; Stephen G. Baxter, Reg. No. 32,884; Martin M. Zoltick, Reg. No. 35,745; Robert W. Hahl, Reg. No. 33,893; Richard L. Treanor, Reg. No. 36,379; Steven P. Weihrouch, Reg. No. 32,829; John T. Goolkasian, Reg. No. 26,142; Marc R. Labgold, Reg. No. 34,651; William J. Healey, Reg. No. 36,160; Richard L. Chinn, Reg. No. 34,305; Steven E. Lipman, Reg. No. 30,011; Carl E. Schlier, Reg. No. 34,426; James J. Kulbaski, Reg. No. 34,648; Catherine B. Richardson, Reg. No. 39,007; Richard A. Neifeld, Reg. No. 35,299; and J. Derek Mason, Reg. No. 35,270, with full powers of substitution and revocation.

(30)

Addresser toute correspondance à:

Send Correspondence to:
OBLON, SPIVAK, MCCLELLAND, MAIER & NEUSTADT, P.C.
FOURTH FLOOR
1755 JEFFERSON DAVIS HIGHWAY
ARLINGTON, VIRGINIA 22202 U.S.A.

Adresser tout appel téléphonique à:
(nom et numéro de téléphone)

Direct Telephone calls to: *(name and telephone number)*

(703) 413-3000

Nom complete de l'~~unique ou~~ premier inventeur Marc BAVANT APRIL 11, 2000 Signature de l'inventeur Date Marc Bavant	Full name of sole or first inventor Inventor's signature Date
Domicile 75019 PARIS FRANCE	Residence
Nationalité Française FRX	Citizenship
Adresse Postale 21, rue Clavel 75019 PARIS FRANCE	Post Office Address
Nom complete du second co-inventeur, le cas echeant Michel DELATTRE APRIL 11, 2000 Signature de l'inventeur Date Michel Delattre	Full name of second joint inventor, if any Second inventor's signature Date
Domicile 92100 BOULOGNE FRANCE	Residence
Nationalité Française FRX	Citizenship
Adresse Postale 95, rue de Bellevue 92100 BOULOGNE FRANCE	Post Office Address

(Fournier les mêmes renseignements et la signature de tout co-inventeur supplémentaire.)

(Supply similar information and signature for third and subsequent joint inventors.)

8/97

French Language Declaration

3-00

Nom complet du troisième co-inventeur, le cas echeant	Full name of third joint inventor, if any
David MOUEN MAKOUA APRIL 11, 2000	
Signature de l'inventeur Date	Third Inventor's signature Date
David Mouen MAKOUA	
Domicile	Residence
92000 NANTERRE FRANCE	
Nationalité	Citizenship
Française FRX	
Adresse Postale	Post Office Address
110, rue de St Cloud	
92000 NANTERRE FRANCE	

Nom complet du quatrième co-inventeur, le cas echeant	Full name of fourth joint inventor, if any
Signature de l'inventeur Date	Fourth Inventor's signature Date
Domicile	Residence
Nationalité	Citizenship
Adresse Postale	Post Office Address

Nom complet du cinquième co-inventeur, le cas echeant	Full name of fifth joint inventor, if any
Signature de l'inventeur Date	Fifth Inventor's signature Date
Domicile	Residence
Nationalité	Citizenship
Adresse Postale	Post Office Address

Nom complet du sixième co-inventeur, le cas echeant	Full name of sixth joint inventor, if any
Signature de l'inventeur Date	Sixth Inventor's signature Date
Domicile	Residence
Nationalité	Citizenship
Adresse Postale	Post Office Address

(Fournir les mêmes renseignements et la signature de tout co-inventeur supplémentaire.)

(Supply similar information and signature for third and subsequent joint inventors.)